X-613-67-544

NASA TM X- 63042

INVESTIGATION OF POSSIBLE ABUNDANCE ANOMALIES IN CLOSE BINARIES OF SPECTRAL TYPES A0-A2 F5-F6 (IV-V)

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NOVEMBER 1967

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GREENBELT, MARYLAND

INVESTIGATION OF POSSIBLE ABUNDANCE ANOMALIES IN CLOSE BINARIES OF SPECTRAL TYPES A0 - A2 & F5 - F6 (IV - V) +

by

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ABSTRACT

Eleven close spectroscopic binaries in the spectral regions A0 - A2 and F5 - F6 (IV - V) were observed with dispersion of 13.5 A/mm at the Coude focus of the 84-inch reflector of the Kitt Peak National Observatory. The program was originally intended as an extension of a work by Abt (1965). Preliminary analysis shows the following results. The spectra of both components of a double line system 50 Dra show metallicity, HR 5317, which is classified as middle F type, shows characteristics of a metallic-line star, and another middle F type system HR 4536 shows similar spectral characteristics to a lesser extent. An apparent over-abundance of Ca was found for HR 5317 and HR 4536. Nine out of eleven close binaries observed show metallicity. When metallicity is observed, it appears to be more enhanced for a shorter period, though a generalization is not possible with the number of stars observed in this work.

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* Visiting Astronomer, 1967, Kitt Peak National Observatory.

** Operated by the Association of Universities for Research in Astronomy, Inc., under contract with National Science Foundation.

+ Presented at "Joint Discussion on Stellar Evolution and Close Binaries" at XIII General Assembly of the IAU, August 1967.

OBSERVATIONS

This investigation was originally conceived as a follow-up on a work by Abt (1965), in which he finds the close binaries, with periods of about 1 to 100 days, and with spectral types of about A4 - F2 (IV - V), to be all Am stars. The stars to be observed were chosen from the "Fifth Catalogue of the Orbital Elements of Spectroscopic Binary Stars"(Moore and Neubauer, 1948). The criteria in making the selection were that the spectral types are A0 - A2 and F5 - F6 (IV - V) and that the periods are between about 1 to 100 days.

Spectra of 11 binary systems were obtained at the Coude focus of the 84-inch reflector of the Kitt Peak National Observatory during three nights in May 1967. In addition to the binary stars, 5 standard spectrum stars, i.e. α Lyr (A0 V), θ Leo (A2 V), σ Boo (F2 V), ι Peg (F5 V) and 110 Her (F6 V), were observed to provide comparisons. The dispersion used was 13.5 A/mm. Typically 2 or 3 spectra were obtained for each object. A spot sensitometer was employed to furnish calibrations for the plates.

DISCUSSION OF THE OBSERVATIONS

The spectra obtained were first examined on a spectrocomparator. Tracings of the spectra were obtained using a microdensitometer with a slit width corresponding to about 0.07A.

Conti's criterion was adopted in investigating metallicity for the binary stars in the A0 - A2 region, although other spectral features were also examined. Conti (1965) has reported that metallicity can be found for early A-type stars using the relative weakness of the Sc II line at 4246A and the relative strength of the SrII line at 4215A. This ratio, which is called Sc/Sr, is close to unity for a normal star in this spectral region.

In case of the stars in the F5 - F6 region, strengths

of Balmer lines and metallic lines were compared with those of the spectra of the standard spectrum stars.

The results are tabulated in the accompanying table.

In the spectrum of δ Lib, both ScII and SrII are too weak to be compared meaningfully. In case of ω UMa, the blending of lines are such that it is not possible to evaluate Sc/Sr reliably. The spectra of TX Leo are rather unusual. The ratio Sc/Sr is slightly greater than unity, while, in the spectra of θ Leo, Sc/Sr is never greater than unity.

50 Dra is a double line system. In two out of the three spectra obtained for this binary system, the spectral lines of the two components are well separated making it possible to examine the lines of each component separately. Corresponding lines of both components are of similar intensity. The Sc/Sr for both components are distinctly smaller than unity indicating that both primary and secondary components are metallic. In another double line system η Vir, the separationsof the spectral lines of the two components were very small at the time the two spectra were obtained, and it is not possible to evaluate Sc/Sr for the components separately.

HR 5317, which is classified as F6 IV in the Bright Star Catalogue (Hoffleit, 1964) has Balmer lines stronger than those of 110 Her (F6 V), while its metallic lines indicate a later spectral type than 110 Her. This is a characteristic of a metallic-line star. The difference in spectral types, as may be determined independently from the Balmer lines and from the metallic lines, appears to be about three tenths of a spectral type. It was also found that there exists an apparent over-abundance of calcium. An apparent over-abundance of calcium was reported several years ago by Preston (1961) for an early to middle F type star HD 174704, which he classifies as a metallic-line star. HR 4536, classified as F5 in the B. S. Catalogue, shows metallic lines which are slightly stronger

than those of ι Peg (F5 V). The Balmer lines of HR 4536 are only very slightly stronger than those of ι Peg, and the difference in spectral types, as determined from the Balmer lines and from the metallic lines, appears to be about a tenth of a spectral type.

In this survey, when metallicity is found in a binary system, it appears to be stronger for a binary with a shorter period, although it is not possible to make any generalization with the limited number of binary systems observed in this study.

It is to be noted that 9 out of 11 close binary systems, if we include ω UMa classified as a metallic-line star by Conti (1965), are found to have metallic characteristics.

CONCLUDING REMARKS

According to Abt (1961) all metallic-line stars are members of spectroscopic binary systems. Also, according to more recent work by Abt (1965), which was quoted earlier, all short period binaries in the spectral range about A4 to F2 (IV - V) are found to be Am stars.

The possibility may be considered that metallicity is a norm rather than a peculiarity for close binaries, at least within a certain spectral range.

Further investigations of close binaries in the middle to late F spectral region are desirable. This is especially so in view of the fact that the absence of deep convective zones for stars earlier than the early F type has been suggested by some to have relevance on metallicity.

Some years ago, F. B. Wood (1962) suggested, in a somewhat different context, a possibility that secondary components of close binary systems are metal rich. A systematic spectroscopic investigation, at high dispersion, of double line systems, particularly in the early A region, may yield useful information on the metallicity in secondary components. For F type stars, an investigation of metallicity in double line systems may be a rather difficult undertaking due to the absence of a convenient criterion.

ACKNOWLEDGEMENT

The author is indebted to Dr. H. A. Abt for helpful advice and discussions in conducting this investigation. Interesting conversations with Professor F. B. Wood and Professor K. Wurm are appreciated. It is a pleasure to thank Dr. G. E. McCluskey for his assistance in reduction of the data and for useful discussions. Special thanks are due Mr. M. Snowden for his kind assistance in obtaining the observations. Also, various assistance and cooperations received from the staff of the Kitt Peak National Observatory are gratefully acknowledged.

This work has been supported by NASA National Academy of Sciences - National Research Council Postdoctoral Research Associateship.

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STAR	BS (=HR) NO.	V	B-V	BS Sp	LICK BINARY CATALOG NO.	P (days)	Sc/Sr	METALLICITY	COMMENTS
δ Lib	5586	4.92	−0.01	AO	271	2.33	?	?	ECLIPS. VAR.
—	6641	6.28	—	AO	328	2.82	$\ll 1$	YES	
ω UMa	4248	4.75	—	A1 V	208	15.84	? c*	?	CONTI FINDS Sc/Sr <1.
50 Dra	7124	5.36	—	A1	359	4.12	$\ll 1$	YES	DOUBLE LINE SYSTEM. BOTH COMPONENTS SHOW METALLICITY.
φ Aql	7610	5.23	−0.02	A1 V	384	3.32	$\ll 1$ c	YES	
TX Leo	4148	5.63	—	A2	201	2.45	≥ 1	NO	ECLIPS.VAR.
η Vir	4689	3.88	+0.02	A2 V	231	71.9	< 1 c	YES	DOUBLE LINE SYSTEM. VAR.?
—	6917	5.83	+0.06	A2 V	346	9.61	$\ll 1$	YES	
ι Del	7883	4.42	+0.04	A2 V	409	11.04	$\ll 1$ c	YES	
—	4536	5.72	—	F5	222	32.86	—	(YES)	BALMER AND METALLIC LINES SLIGHTLY STRONGER THAN ι PEG (F5V).
—	5317	5.93	+0.47	F6 IV	262	2.70	—	YES	BALMER AND METALLIC LINES STRONGER THAN 110 HER (F6 IV).

*c INDICATES STARS OBSERVED ALSO BY CONTI (1965).